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FEASIBILITY STUDY OF ALTERNATIVES

VOLUME I

**KALAMAZOO RIVER PCB PROJECT
KALAMAZOO AND ALLEGAN COUNTIES, MICHIGAN**

STATE OF MICHIGAN CONTRACT NUMBER 1611

NUS PROJECT NUMBER 7339

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5.4 Discussion of Results

No Action

Model results indicate that, even under the no-action alternative, PCB concentrations in Kalamazoo River fish will be reduced over the long term. This will occur through two principal mechanisms: sediment burial and sediment flushing. Sediment burial will occur in the impounded areas (the depositional areas). Through this process, contaminated sediment is isolated from the aquatic ecosystem by burial beneath clean sediments. A noteworthy shortcoming of this process is the potential reexposure of contaminated sediments if an extreme hydrologic event (e.g., a flood) erodes the overlying materials. Sediment flushing will occur in the erosional areas. This process removes PCBs from the in-stream sediments through resuspension, diffusion, and turbulence. However, even though certain processes will continue to reduce PCB concentrations in Kalamazoo River fish, the model results indicate that a continuation of existing PCB sources will partially offset any process-controlled reductions. Under long-term, steady-state conditions, the minimum goal of lowering the PCB concentration in fish to below 2 ppm will not be achieved in Portage Creek (Reach 1) and in the Kalamazoo River near its confluence with Portage Creek (Reach 2) under a no-action condition.

Portage Creek/Bryant Mill Ponds

The model results for Alternatives B, C, and D indicate that all three alternatives for the remediation of the Portage Creek/Bryant Mill Ponds area will achieve the minimum goal of lowering the PCB concentrations found in carp and bass to below 2 ppm in all reaches. A comparison of the results from all alternatives suggests that remedial actions applied at Portage Creek will have the most significant effect in reducing PCB concentrations in fish (Figure 5-1). Portage Creek remedial actions are particularly effective in Reaches 1 through 7.

Drawn Down Dams (Plainwell, Otsego, Trowbridge)

The model indicates that Alternatives E, F, and G have no effect on the first two reaches of the river. Therefore, the minimum goal of lowering the PCB levels in fish to less than 2 ppm will not be achieved in these upstream reaches. The model also predicts that the other reaches are only slightly improved by the alternatives. In Reaches 8 and 9, these alternatives actually result in a slight increase in the PCB concentrations in the fish. The reason for this increase is that remedial actions taken at these dams result in lower concentrations of suspended sediments. This, in turn, lowers the probability for dissolved PCBs from upstream reaches to attach to solid particles and settle out. Rather, the dissolved PCBs pass through to downstream Reaches 8 and 9 (Allegan City Dam and Lake Allegan).

Impounded Dams (Otsego City, Allegan City, Lake Allegan)

The model results indicate that Alternative H (dredging the three impounded dams) has no effect on the PCB levels in fish in the upstream reaches (Reaches 1 through 3) and little effect in Reaches 4 through 7. However, a significant reduction in PCB levels is observed in Reaches 8 through 10 (Figure 5-1). Alternative H is the only alternative that has a significant effect on the downstream reaches. The fact that only Reaches 8 through 10 show significant effects indicates that dredging Allegan City Dam (Reach 8) and possibly dredging Lake Allegan (Reach 9) would have significant beneficial effects in the last three reaches.

The model results also indicate that Alternatives I and J (Otsego City Dam remedial actions) have no effect on the majority of the reaches. The only significant decrease in PCB concentrations occurs in Reach 5 (Otsego City Dam to Otsego Dam).

Reimpounded Dams (Plainwell, Otsego, Trowbridge)

According to model predictions, implementation of Alternative K (dam reimpoundment) results in a slight decrease in PCB levels in fish from Reach 3

through Reach 9. Reaches 1 and 2 are not affected since they are upstream of the reimpounded dams, and the minimum goal of lowering PCB levels in fish to less than 2 ppm will not be achieved in these reaches.

According to the model, if the drawn down dams are reimpounded (Alternative K), the PCB concentrations in the fish will decrease, even though large quantities of contaminated sediment will be permanently inundated. The reason for this paradoxical finding is that, in the model, predictions of PCB concentrations in fish correspond to long-term, steady-state conditions. The short-term increases in PCB loadings due either to a "first-flush" of PCBs from the newly inundated sediments or to a reentrainment of contaminated sediments are not accounted for. Even the potential long-term release of PCBs from the contaminated sediments was not explicitly modeled due to a lack of understanding of this process. Rather, the model formulation yielded a higher dilution of any PCBs entering the reach (due to a larger volume of impounded water), and also predicted a greater settling of suspended solids due to the lower water velocities. The effective increase in both dilution and deposition resulted in lower PCB concentrations in the water column, and thus in the fish through the partition coefficient. Most the the downstream reaches also exhibit a decrease in PCB concentrations in water and fish due to the increased removal of PCBs behind the reimpounded dams. These results must be used with caution, however. More studies will be necessary before the assumed importance and effects of the various processes under a reimpoundment scenario can be ascertained.

5.5 Summary of Results

In summary, model results indicate that, even under the no-action alternative, PCB concentrations in the Kalamazoo River fish will be reduced over the long term; however, the minimum goal of achieving less than 2 ppm in fish will not be achieved in the first two reaches with no action.

A comparison of model results from Figure 5-1 indicates that remedial actions applied at Portage Creek will have the most significant overall effect in reducing

PCB concentrations in fish, particularly in the upper reaches of the study area. Results indicate that only Alternatives B, C, and D achieve the minimum goal of lowering the PCB concentrations in fish to less than 2 ppm in all reaches. Each of these alternatives involves some remedial action at Portage Creek.

The model results for remedial actions involving the three drawn down dams (Alternatives E, F, and G) indicate that these alternatives have no effect on the first two reaches and only a slight beneficial effect on some of the other reaches. Overall, these alternatives are not very effective in reducing PCB concentrations in fish.

Alternative H (dredging the three impounded areas) is the only alternative that has a significant impact in the downstream reaches (Reaches 8 to 10). On the other hand, the model results indicate that remedial actions at Otsego City Dam (Alternatives I and J) have almost no effect in any of the reaches. Therefore, dredging Allegan City Dam (Reach 8) and possibly dredging Lake Allegan (Reach 9) would have to be considered if short-term improvements in Reaches 8-10 are of high priority in the decision process.

According to model predictions, reimpoundment of the three drawn down dams (Alternative K) will result in a slight decrease in PCB concentrations in fish, even though large quantities of contaminated sediment may be added to the river in the short-term. These results are very dependent on model assumptions regarding the relative importance of PCB release and removal mechanisms after reimpoundment. Additional studies are recommended prior to utilizing these results in support of a final decision.

5.6 Recommendations

Based on results of the model and preliminary cost estimates for the alternatives, the following recommendations can be made:

- Some remedial action should be taken at Portage Creek/Bryant Mill Ponds. A primary focus of this remedial action should be to contain and/or isolate the PCB-contaminated sediments from the river system. Such an action would have the greatest effect in reducing human exposure to PCBs, and would concomitantly decrease PCB levels in fish throughout downstream reaches. Permanent diversion of the creek from Cork Street to Alcott Street (Alternative D1), or lining of the existing channel along with a soil cap for containment of the exposed sediment of the former creek bed (Alternative B), are the most cost-effective alternatives. The environmental benefits of these alternatives are expected to be similar to Alternative D (complete excavation and disposal), and can be implemented for only a fraction of the cost of Alternative D. Note, however, that land acquisition costs have not been included in the reported cost estimate for Alternative D1.
- Better management of the Allegan City Dam impoundment is recommended. The practice of drawing the dam down should be discontinued since an uncontrolled release of PCBs to Lake Allegan and downstream reaches results.
- The removal of the remnant dam structures at the Plainwell, Otsego, and Trowbridge Dams is a low priority recommendation. If properly implemented, this action would result in lowering of the river channel, which would have beneficial environmental effects since the exposed sediments above the river banks would be further isolated from the river.

All other actions on the Kalamazoo River should be considered less cost-effective due to the high costs of implementation and/or conditional due to uncertainties in the predictions. The following comments address these actions and uncertainties.

- Dredging may be a preferred option at Allegan City Dam and possibly at Lake Allegan. However, since this type of remedial action is very costly, further studies are recommended to evaluate this option. If dredging is implemented at Allegan City Dam only, a reduction of carp population in Lake Allegan is recommended to reduce sediment disturbance so that natural sediment burial processes can eventually cover and isolate the contaminated sediments of Lake Allegan.
- Although the model results indicate that reimpoundment would not be detrimental, and may in fact result in a slight improvement in downstream conditions, this action is not recommended at the present time. The model results may not be reliable owing to an incomplete understanding of the consequent effects on controlling processes. Further studies are required in order to more accurately evaluate the effects of reimpoundment.

Future studies on the Kalamazoo River should concentrate on the following:

- More comprehensive quantification of PCB levels in fish.
- Expanded data base on PCB levels in the sediments within the Otsego City, Allegan City, Plainwell, Trowbridge, and Otsego Dam impoundments.
- Additional analyses of suspended solids concentration and corresponding PCB concentrations in the water column in order to quantify resuspension and to refine the value of the partition coefficient. Sampling under high flow conditions when the exposed sediments are temporarily inundated would be particularly valuable.

- Similar analyses of PCBs in sediments and the overlying water to better estimate the respective partition coefficient, with special emphasis on the clayey fiber material. Supporting laboratory studies would also be recommended.
- Additional efforts toward quantifying existing point sources of PCBs, including field sampling of shoreline sludge disposal ponds and treatment plant outfalls.
- Refined estimates of sediment burial rates within the Allegan City, Allegan, and Otsego City Dam impoundments using core profiles, including a related analysis of the depth of the active sediment layer.
- Additional sediment grain size analyses, with an attempt to isolate and quantify the amount of clayey fiber material present.
- Refined estimates of bioconcentration factors for the principal species of fish, including further analysis of any observed differences (e.g., between reaches).
- Studies directed toward a quantification of sediment resuspension in Lake Allegan caused by biodisturbance (i.e., by carp stirring up the sediments).
- Further analysis of flow velocity and channel geometry, including rates of bank erosion, in the three drawn down dam impoundments (Plainwell, Trowbridge, and Otsego).